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STUDIES IN ELECTRICITY.

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I.

SOME of the most difficult problems encountered by the student of electrical science and industry present themselves at the very beginning of his studies, and their nature is indicated in the first questions he usually asks. What is electricity, what are the laws governing its action, and what are the terms so frequently used — volts, pressure, E.M.F., amperes, ohms, etc.? Of the making of textbooks there is no end, and the student or amateur will find standard works in most well-equipped bookstores, at a moderate price, in which he will find these questions answered very fully. Unfortunately, however, the explanation of the various terms and rules are so frequently complicated by mathematics and pure theory, that unless the student has access to a properly equipped laboratory and the services of a skilled instructor, a great deal of tedious labor is necessary to enable him to reason intelligently and appreciate his first problems. These conditions are not usually within the reach of the amateur, and the so-called popular works on electricity are worthless as a real aid to his studies, being largely compiled from manufacturers' catalogues, with a smattering of information taken at random from obsolete works from which the copyright has long since expired.

We will endeavor in this series of articles to "make haste slowly," and to illustrate each principle or rule by simple but comprehensive experiments with apparatus made by the student himself, thus maintaining an even balance between theory and practice, and enabling the student to secure a clear understanding of electrical science as it exists to-day.

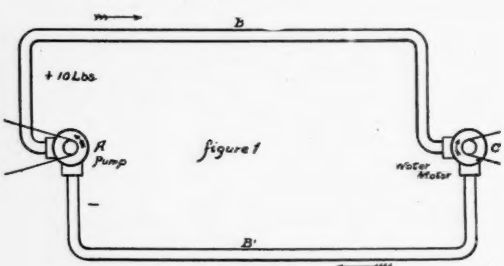
To the question, "What is electricity?" no answer can be given. We know it only in the same way in which we recognize light and heat; namely, by the effects produced by its action. At this early stage it would be useless to examine in detail the theories most commonly accepted regarding the nature of electricity itself. We can only state that it is one form of the everlasting energy of nature, and displays itself to us as one member of the great trinity of natural forces — heat, light and electricity.

For many centuries electricity was only known in the impressive form, still exhibited in nature's laboratory by the thunderstorm, and in the feeble attraction of excited amber or resin for particles of paper or other light substances. The fact that this phenomenon of attraction was produced by the same force that forms lightning, was not suspected or proved until comparatively recent times.

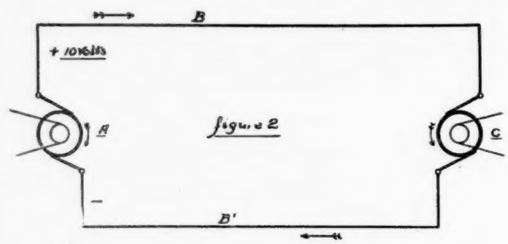
The first and one of the most important facts to be noted by the student is that there is only one kind of electricity, and the difference between the lightning's flash and the feeble current generated by a single cell of battery is only one of degree; both effects being produced by the same force, the results differing only with the varying conditions in each case, and in direct accordance with well-known laws. The early experimenters conceived electricity to be a sort of fluid, and drew close distinctions between the various forms of electrical display with which they were familiar. Atmospheric electricity, frictional electricity, galvanic, and the electricity produced by earth currents, etc., were treated as though they were

entirely separate forces. It is true that the action of electricity in many respects bears a striking similarity to the flow of fluids, and many of the terms and expressions used by the early scientists have been continued to the present time. As the purpose of these articles is to give the home student a practical knowledge of electricity as it is used in every-day life, as illustrated by the telephone, telegraph, electric light and power, electroplating, etc., the state of electrical action under high pressures, and known as static electricity, will not be taken up until a good start has been made in the more important and useful branches of the science.

Electrical action, whatever its form, is controlled by the amount of pressure, the quantity of current flowing, and the time in which such action takes place in any given circuit. The term circuit is applied to any electrical system allowing of a flow or circuit of electricity through its various parts. To take a familiar example: An electric-doorbell circuit is composed of a generator or battery, wires connecting the battery with the circuit-closer, or push-button, and the bell. The office of the push-button is to break or open the circuit at this point, so as to prevent the current flowing through the system and operating the bell until this contact is closed by pressing the button, when the current will at once flow through the circuit and operate



the bell or signal. As stated above, the action of a current of electricity in such a circuit resembles in many respects the behavior of a fluid under pressure. It will assist the student to a better understanding of the laws governing electrical phenomena by examining the accompanying illustrations: In Fig. 1, A represents a force pump of any type, here shown as a rotary pump, and driven by any source of power. C is a water motor of the same type, and B and B′ the pipes connecting the two machines. It is evident that if the pump A be driven so as to force water into the pipe B under sufficient pressure, the water motor C will revolve and may be used to furnish power, as indicated by the belt. It is also evident that all the water forced through the motor must return to the pump, so that a continual circulation of water takes place in the system so long as the pump is operated and the conditions remain unchanged. The water in the above case can only flow in one direction, as indicated by the arrows. If the pipes and apparatus are only strong enough

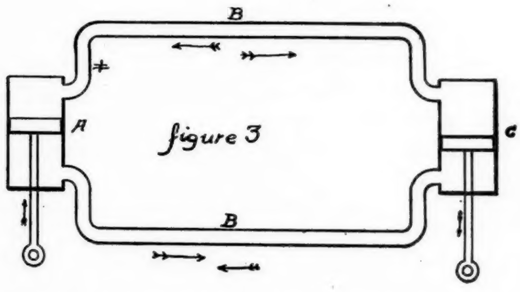


to run under the moderate pressure of say 10 lbs. to the square inch, and the pump could be driven at a higher rate of speed, so as to keep a pressure of say 1,000 lbs., it is apparent that the pipes and joints, or the weakest point of the system, would soon begin to leak, and finally burst, and the water escape.

It is also true that the rapid flow of water in the system will generate a certain amount of heat, owing to the friction between the water and the pipe, and they would become warm to an extent depending on the rate of flow and friction in the pipes. Now compare this diagram with Fig. 2, and the similarity will be apparent. A represents any source of electricity, such as a battery or dynamo, B and B′ conducting wires, connecting the dynamo with the electric motor C. If the dynamo be operated and the connection is complete, as shown, the current of electricity will flow in the direction indicated by the arrows, and the electric motor C will revolve and do mechanical power in precisely the same manner as the water motor in Fig. 1. The wires B and B′, and other parts of the system, will also become heated, the amount of heat depending upon the rate at which the current flows through the circuit and the resistance offered to the current by the wires. If the electrical pressure could be raised sufficiently high, the electricity would escape from the wires

at the weakest point of the system, and a general display of fireworks with destructive effects would be noticed, thus corresponding to the bursting of water-pipes under heavy pressure in Fig. 1. The water pressure in the latter case was stated to be 10 lbs. to the square inch. In the circuit shown in Fig. 2 the electrical pressure is given as 10 volts, as electricity has no weight and is not a material substance. It is evident that we cannot use the term *pounds* in connection with the pressure produced by the dynamo.

The *volt* is the unit of electrical pressure, and derives its name from one of the early investigators, Volta. The manner in which this unit of pressure is determined will be explained in future papers. At the present time it may be stated that a cell of gravity battery using copper, zinc and a solution of sulphate of copper, delivers a pressure of very nearly one volt per cell, regardless of its



size. This battery is a familiar sight in telegraph offices, and it is used almost exclusively for this service. The pressure given by the familiar bell battery used for operating doorbells, annunciators, and consisting of a carbon and zinc cylinder in a solution of sal ammoniac, delivers a pressure of very nearly $1\frac{1}{2}$ volts, while other batteries, to be described, will produce a pressure of 2 to $2\frac{1}{2}$ volts per cell. A number of cells may be connected up in such a way as to add the pressures, and thus any desired voltage may be obtained. The current produced by batteries of this sort is continuous; that is to say, the current continually flows through the wires in one direction, as shown by the arrows in Fig. 2. The greatest electrical pressure known is exhibited in a flash of lightning. In this case it may be so high as to force its way through a mile or more of air, and the electrical pressure, many millions of volts.

To express the quantity or amount of electricity flowing in a circuit, the term *ampere*, also derived from a well-known scientist, Ampere, is used. In Fig. 1 we stated that a water pressure of 10 lbs. was produced by the pump A. This statement, however, does not give us any idea as to the amount of water flowing in the pipes at any given time; and if we wish to know this point, we should expect to be told that the rate of flow, or the amount of water passing through the pipes or through the water motor C, would be so many gallons per minute. The latter expression, of course, indicating the rate of flow. This is precisely what the term ampere indicates in an electrical circuit, and the derivation and the method of obtaining the standard is reserved for a future writing.

Once more referring to Fig. 1, we stated that the pipes and apparatus would become heated by the water passing through them under the pressure produced by the pump C, and we should state that this heating was due to the friction or resistance to the flow offered by the pipes. In an electric circuit, as illustrated in Fig. 2, the term resistance is used instead of friction. The unit of resistance, named for another investigator, Ohm, is called the *ohm* (pronounced like home without the *h*); and without at present going more deeply into the subject, it may be stated that an ohm is the amount of resistance offered by a wire or any other substance that will allow a current of one ampere, at a pressure of one volt, to pass through it.

Many of our readers have no doubt heard of the alternating current, in connection with light and power systems. We have already stated that a direct current is one that is flowing continually in one direction, around and through the circuit. An alternating current, as its name indicates, is a current of electricity that flows through a circuit, first in one direction and then in the other. This is well illustrated in Fig. 3, which shows two pumps of the ordinary or piston type, connected together and filled with water on both sides of the piston and in both pipes. It is evident that if the piston in figure A is pushed in and out, the piston in B will follow the motion of C exactly, or will be alternately pushed in and out by the action of the pump A, and the strokes of the piston in pump or motor C may be used to deliver power.

If the pump A was operated so as to deliver a pressure or thrust of 10 lbs., first in one direction and then in the other, we should have the same amount of power delivered to the pump or motor C, as in the case of Fig. 2. This illustration represents very clearly the action taking place in an electrical circuit supplied by a generator of electricity, delivering an alternating current. In practice, a dynamo of special construction is used, which delivers a current first in one direction, then in the other, at a very high rate; the number of alternations in many cases being as high as 16,000 per minute, or 266 per second. If electric lights were operated by a slowly varying current of a few hundred alternations per minute, the lights would flicker so perceptibly as to be useless.

The alternating current has peculiar properties not possessed by the direct current, and which renders it unfit for many applications in electrical industry. It is, however, largely used for lighting, and for the transmission of power in large amounts. Direct currents are almost universally used for the operation of motors, street railway systems, electroplating, telegraph, telephone, and many other applications. The student should bear in mind that a current of electricity, whether it be derived from a battery or a dynamo, is the same, and will produce equal results in any given case. For instance, if a system of electric bells has been operated by say 10 cells of battery producing a pressure of 15 volts, the system will work equally well if a dynamo is substituted for the battery, provided the dynamo is wound and operated so as to produce the same pressure, 15 volts, and has a current capacity equal to or greater than the battery itself displays. The principle on which all dynamos operate, known as magnetic induction, opens up an entirely new field of investigation, and must be deferred for future study.

We will in the next chapter take up the practical construction of an experimental battery and apparatus for demonstrating clearly the principles and laws of electrical action just described.

(To be continued.)

The practical sense of the German nation is evidenced by a ministerial decree forbidding motor-car racing in public thoroughfares throughout Germany. It is noticeable that strong opposition to automobile "scorching" is also appearing in the United States.

HERTZIAN WAVES.

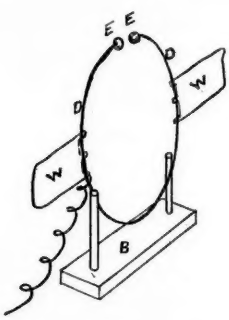
If a stone be thrown into a pool of still water, the motion of the stone causes a disturbance on the surface of the water. Circular waves radiate from the point at which the water was struck, diminishing in height until no longer visible. The movement of these waves is slow; the eye can easily follow them and count the number of waves per minute. Other waves in a more elastic medium than water are found to be much more rapid in movement. The striking of a bell causes it to vibrate, which vibration imparts wave motion to the surrounding air. Our ears are so constructed that this wave motion, if the rate be not less than 16 nor more than 44,000 per second, is transmitted through the tympanum and nerves of the ear, and we become sensible of it as Sound. Certain bodies are responsive to a particular rate of vibration. If a violin be played close to a wine-glass in exactly the same tone as the vibration rate of the wine-glass, the wave motion from the violin will set up a vibration in the glass, sometimes so violent as to cause the glass to break in pieces. Many interesting instances of this harmony of vibrating rate are recorded in the various textbooks on Physics.

Sound waves, while much more rapid than the water waves, are still comparatively slow when we consider the rapid vibrating motion of heat waves. The rapidity of these waves is beyond the ability of the mind to comprehend except by comparison. That degree of heat termed "bright red" requires the atoms of the body giving out this heat to vibrate at the rate of 400 billion times per second. It has been discovered that, under certain conditions, electrical waves radiate through space and have the power to influence suitable objects prepared for that purpose. The particular form of electrical wave under consideration is that known as Hertzian waves, so termed from the comprehensive discoveries of Dr. Heinrich Hertz, of Carlsruhe and Bonn. By means of a series of masterly experiments based upon certain phenomena previously discovered by other scientists, Dr. Hertz, between the years 1886 and 1891, added greatly to the knowledge of these electric waves and their effects on adjacent bodies, enabling them to be put to practical use in wireless telegraphy.

These Hertz waves do not have the extremely

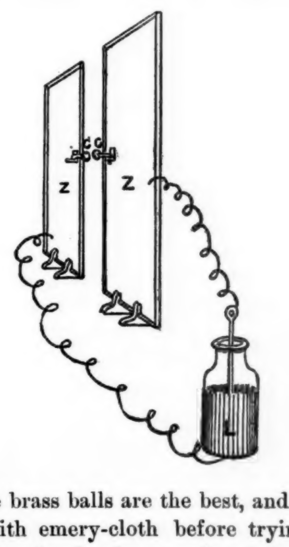
rapid vibratory rate of heat waves, though, as compared with sound waves, they are still very rapid, their vibrations being, as near as has yet been discovered, approximately 230 millions per second. These waves are set up by any sudden electric discharge, such as a lightning flash, or in a less degree by a spark from a sparking or induction coil or Leyden jar. They are made evident to our senses by suitable apparatus that, being adjusted to the same rate of vibration, receives the wave impulses and acts in unison with them. We may soon be able to learn of the approach of electric storms by means of instruments that will receive the electrical waves set up by the distant lightning flash.

The apparatus for demonstrating electric-wave action is simple and may easily be constructed at small cost. Procure two sheets of heavy zinc 16″ square, and mount them in a light wooden frame.



Small picture-frame moulding makes a neat-looking frame. At the center of one edge of each plate (Z) solder an L-shaped strip of zinc, the projecting piece being about $\frac{1}{2}$″ long, and having a $\frac{1}{8}$″ hole through it. To one end of two pieces of brass wire 4″ long and $\frac{1}{8}$″ in diameter, fit brass balls (C) 1″ in diameter. The other ends of the wire are then put through the holes in the zinc angle-piece, and when the plates are placed in line, the two balls will face each other. The plates should also be fitted with ebonite or glass feet, raising them $2\frac{1}{2}$″ or 3″ from the level. At the outside of one plate and in the lower outside corner of the other, bore small holes, and connect, by soldering, two pieces of insulated copper wire, size 16 or 18, which are to connect with the Leyden jar. This Oscillator, as Dr. Hertz named it, if placed on a stand with the plates in line and the balls from $\frac{1}{4}$″ to 1″ apart, according to conditions, will, when connected to the outer and inner coatings of the charged Leyden jar (L), set up powerful electrical or Hertz waves in the surrounding medium at the instant the discharge takes place between the balls of the "oscillator" plates.

These waves are taken up and made evident by a simple form of receiver known as Hertz's Resonator. This consists of $\frac{1}{4}$″ brass rod 5 feet long bent into the shape of a nearly complete circle 18″ in diameter. The unconnected ends are fitted with two 1″ brass balls; the distance between them is adjusted by bending the rod. Wings of thin sheet copper 6″ wide and 10″ long are fastened to each side of the rod by twisting around the rod extension strips that were left on the wings when they were cut out. In place of the brass balls the ends of the rod may be turned into two small circles, and soldered to make a perfect



joint. The brass balls are the best, and should be polished with emery-cloth before trying experiments. The circular brass rod (D) is held suspended by two round pieces of wood 8″ long and 1″ thick, the lower ends of which rest in holes bored in the base (B). Two round-headed brass screws on each upright hold the brass rod in place, one screw on each side of the rod. It will add materially to the success of the experiment if one wing is connected by a piece of covered copper wire to a "ground." The nearest gas or water pipe will answer. The base is a heavy block of wood with wooden uprights, upon which to fasten the circular rod.

The Leyden jar may be made from an ordinary quart glass milk or preserve jar, provided it is made of the right kind of glass: that is, a good insulator. To test this point, carefully clean and dry the bottle. When quite dry (it must also be cold), rub it briskly on the outside with a warm silk handkerchief. Reject any jar that does not quickly become charged so as to give a distinct spark. A sound wooden bung is then fitted to the mouth. The bung should be a new one, entirely free from acid or grease. A hole is bored through the center to admit a piece of brass rod about ⅛″ in diameter and one-third longer than the bottle. The rod should fit very tight, and after putting it through the bung the top of the latter is given a liberal coating of red sealing-wax. The outside or top end of the rod is fitted with a brass ball 1″ in diameter, and to the inside or lower end is soldered a piece of brass chain 3″ long to aid in making a good contact between the inside coating of the jar and the rod. In place of the brass ball the rod may be turned to form a circle, but the joint must be carefully soldered and filed perfectly smooth.

The jar is then given the coating of tin foil, the inside being done first. The tin foil used should be heavy enough to withstand the work without tearing. A piece is first cut into a circle a trifle smaller than the outside diameter of the jar. Carefully cover one side with hot glue, and place it upon a dauber. This is made by wrapping a tuft of cotton wool to one end of a small stick and covering with cloth. Holding the jar with the mouth down in one hand, press the tin foil, by means of the dauber, firmly up against the bottom of the jar; then turn the jar upright and finish pressing the tin foil smoothly into place. The side coating should cover three-quarters of the distance from the bottom to the bung and lap over the bottom layer slightly. Owing to the difficulty of handling one large piece, it may be cut into halves. One side of the tin foil is covered with glue, placed lengthwise on the dauber and holding the jar horizontally, inserted in the jar. A quick turn of the dauber will allow the foil to drop lightly against the inside of the jar, when it may be set in place and smoothed firmly against the glass. The other half is then placed in a similar manner.

The outside is then coated in the same way and to the same height as the inside. It will not be necessary to divide the outside coating. The coatings should get thoroughly dry before using the jar. The proper apparatus for charging the jar is a Wimshurst machine; a description of the construction of one will appear in a future issue. In the absence of such a machine the jar may be charged from a rapidly moving leather belt, such as can be found in almost any factory. Hold the jar with one hand around the outside coating and the top of the brass rod about 1″ away from the belt. A few minutes in this position will allow the jar to be fully charged. Do not try to discharge the jar by making a circuit with the hand, as a strongly charged jar will give a shock that would be far from comfortable.

The discharge of the Leyden jar is made by bringing the ends of one of the connecting wires to the outside coating and the end of the other wire to the terminal knob of the inside coating. A sharp discharge will then take place between the balls (C and C′), provided all the parts are in proper condition. Some adjusting may be necessary to determine this. The waves set up by these discharges, on impinging on the wings (W) of the Resonator (this being placed eight or ten feet from the oscillator), set up sympathetic surgings in the ring (D) and these overflow at the spark gap between the two balls (E). The walls of a room offer no obstruction to the passage of these waves, but another current of electricity in the path to be traversed will interfere with it. Much interesting instruction may be derived from experiments with this apparatus.

THE great objection to electric motors — that they will not run far enough without recharging — is said to be overcome. It is recorded that recently in England a circuit of 94 miles was run without recharging. It was done with a battery of 42 four-plate cells, with a capacity of 180 ampere-hours. The carriage was a four-wheeled dogcart, with two motors of two and one-half horse-power each. In going down grade the motors were reversed, thus making dynamos for charging the accumulators. In this way the current was not only saved, but a new current actually generated, rendering the battery stronger at the bottom of the grade than it was at the top.

ELECTRIC BELL FITTING.

I.

A RESIDENCE.

The use of electric bells is now so universal as to require no description of their adaptability to many household requirements. Simple in construction, easily fitted to new or old buildings, needing but little attention in operation, and serving so many useful purposes: any one of ordinary mechanical ability can, with but little expense, learn to make them or fit up a dwelling, office, factory or other place where they may be desired.

The essential parts are a battery for generating the current, the bell, a push button or buttons for closing the circuit and wire. The battery, of one or more cells, may be one of several different forms, depending upon the location and service for which it is intended. It is quite important that the battery used should be reliable and properly set up, as failure at this point affects the whole system, while a broken wire or bell may disable only a single point. The size of the battery is regulated by the amount of work required. Too small a battery would become quickly exhausted, the bells would ring faintly, or not at all, and disappointment follow, where, with a proper battery, very satisfactory service would be secured. Batteries that are overtaxed exhaust much sooner in proportion than do those of adequate size. One horse will fail to haul a load that two horses would have no difficulty in hauling for a long distance.

The Battery.

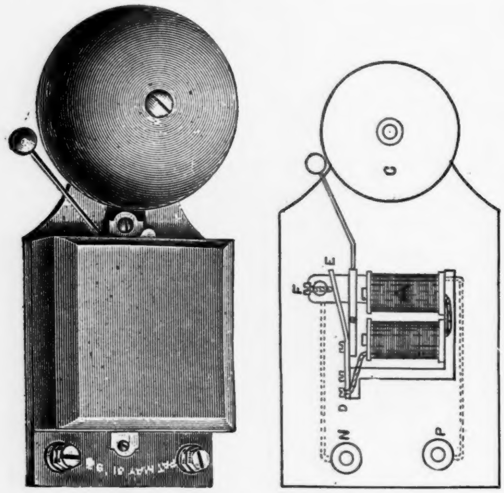
The Leclanche Battery is the form most generally used for electric bell work, although the Fuller or Edison-Lalande is used where the work is excessively heavy. For most places the Leclanche will be found adequate. The Leclanche cell consists of a glass jar, a zinc rod, the positive element; and a carbon plate packed in porous cup with a mixture of carbon and peroxide of manganese, which form the negative element. The porous cup, after being packed, is covered with a preparation of pitch. When these parts are assembled, the exciting fluid, a solution of sal ammoniac, is added. The solution should fill about two-thirds of the jar, and should be strong enough so that when the water has taken up all the sal ammoniac it will, there will be a little left in the bottom of the jar. So long as the wire circuit is open or broken no chemical action takes place; but when the button is

pressed, and the circuit closed, an electric current flows from the positive pole to the negative, and a chemical reaction takes place. The solution of sal ammoniac (chloride of ammonia) is decomposed, the chloride unites with the zinc to form chloride of zinc, while the ammonia extracts oxygen from the manganese, forming a soluble compound on the surface of the carbon. While the cell is working, the zinc rod is being dissolved, the manganese gives up oxygen, and the carbon remains unaltered. In time the zinc rod would have to be replaced with a new one, and a fresh solution of sal ammoniac replace the old one, which contains an excess of chloride of zinc. The peroxide of manganese absorbs oxygen from the air when the cell is not at work, to replace that extracted by the ammonia.

The top of the glass jar is covered, both inside and out, with a narrow coating of paraffin wax, to prevent the salts from creeping out of the jar and soiling the shelf upon which it rests. Where the paraffin has not been properly applied or rubbed off, the salts will at times gather on the outside of

the jar. This can be corrected by cleaning off the salts, and recoating the jar with paraffin, obtained by melting a piece of wax candle in a cup placed in hot water. This description of a Leclanche cell is given to enable the reader to have a general idea of its parts and working. At another time a more complete description will be given, in connection with their manufacture out of such articles as may at times be discarded in the home.

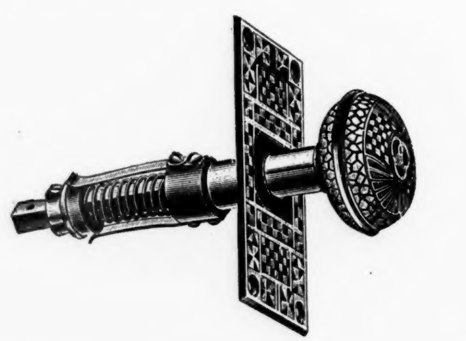
Several excellent forms of "dry batteries" are now much used for this work, and obviate all trouble with liquids, being purchased all ready for work when connected with the wires.



The Bells.

The form of bells generally used is that known as the vibrating or trembling bell (see Fig.). While the circuit is closed the bell will continuously sound, due to the rapid vibrations of the striker or hammer. The parts are: an electro-magnet, A, a vibrating armature, B, upon one end of which is the hammer, a bell of wood or metal, C, and connecting wires, screws and terminals. Upon closing the circuit the current enters the terminal, P, flows around the coils of the electro-magnet to D, continuing through the armature B and contact spring E to the screw F and the wire connection to the terminal N. In its flow around the electro-magnet the current has magnetized the cores, which now exert an attraction for the armature, causing it to approach the poles. This causes the hammer to strike the bell. This movement of the armature has brought the contact spring away from the contact screw, breaking the circuit. The breaking of the circuit prevents the current from exciting the electro-magnet, and the cores cease to attract the armature, which, owing to the tension of the spring, moves back to its former position, again closing the circuit; the current again enters the electro-magnet and the movement of the armature is repeated. These movements continue so long as the button is pressed, and are quite rapid.

Should a bell not work as here described, the cause of the trouble will probably be found either in the cores of the magnet or the adjustment of the contact screw or armature spring. The armature spring should be flexible, and yet keep in contact with the contact screw. If, after closing the circuit, the armature seems to cling to the poles of the magnet, the probability is, that the cores are not made of suitable iron, which should be very soft; as only soft iron will quickly demagnetize, which is very necessary in electro-magnets. The proper adjustment of the contact screw can readily be secured by a little experimenting. If the armature is left too far away from the magnets, the ring will be a feeble one. A piece of watch-spring may be used to press lightly either side of the armature spring while the bell is ringing, and if the ringing improves, the necessary adjustment of screw or spring is at once evident.

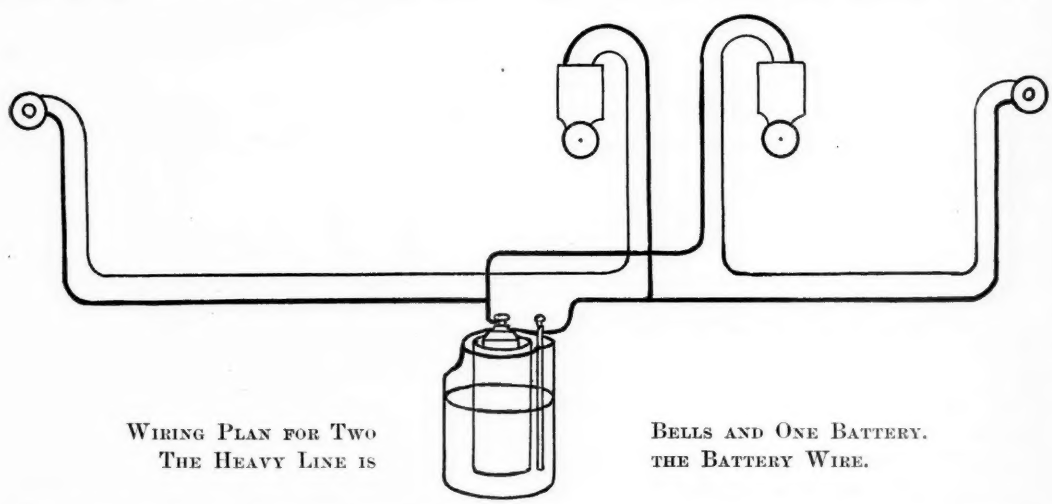


Setting Up.

To illustrate the method of setting up an electric bell outfit, it is assumed that the service to be secured consists of two bells, one for the front entrance of a dwelling and the other for the rear entrance, and that the bells are to be placed in the

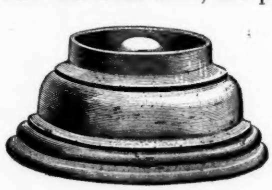
kitchen or rear hall, to ring where a servant may hear them.

The location of the battery is first determined, one cell being large enough for this work. It should be in a place where it will not freeze or yet get too warm. The cellar usually is the most suitable, as the temperature does not vary greatly in the different seasons, and wires may be run to it handily from any part of the house. An empty wooden box, of suitable size to hold the battery, should be nailed to a post or to the timbers of the floor above. The carbon is then placed in the jar, which is then filled about two-thirds full of water. The sal ammoniac is then added and the zinc placed in position. Several hours are required before the cell is strong enough to properly ring the bell. The the wires run through the hole. If no hole is there, one will have to be bored with a small bit or bell-hanger's gimlet. A similar hole through the floor will enable enough of the two wires to be pushed up from the cellar to reach the push-button or knob, with a little wire to spare for connections. If a push-button is used, unscrew the cover, push one wire through one of the small holes beside the screw, remove about one inch of the insulating covering, twist the wire one turn around screw, then tighten screw. Push the other wire through the other hole, and attach in the same way. Pull the wires back until the push-button lays flat against the casing of the door. If the wires prevent this, with a knife or chisel cut grooves in the casing for the wires, and the button



Wiring Plan for Two Bells and One Battery. The Heavy Line is the Battery Wire.

wire is now strung; and, to avoid confusion, two colors of covering are used, one color for the battery wire and one for the bell and push-buttons wires. To wire the front door, the place for the



push-button is determined. If a pull-knob of a doorbell is to be found, this may be utilized, or it may be taken out and an electric pull-knob substituted. A push-button may also be used, and can then be screwed to the casing. The wire should be tacked at intervals to keep it in place, care being used not to set the tacks so hard as to break the wire. The route of the wire should be as inconspicuous as possible. Specially prepared hollow molding can be obtained to cover wires where this is desirable. Returning to the cellar, the wire is strung along the timbers of the floor above in any way that may seem desirable, the battery wire being strung to the battery and the other wire to the point in the floor underneath the bells. Sufficient wire is measured to reach the bell before cutting.

The wiring for the rear door is done in a similar manner. The first battery wire may be tapped at

any place, and a branch spliced on, if a saving of wire can be effected thereby. The return wire to the battery is strung to the bell, and this may likewise be spliced for a branch, the only requisite being a complete circuit of wire from the button to bell and battery; the button being the place where the circuit is open until closed by pressure. When splices are made, care must be used to fully insulate the point with tape prepared for that purpose. If such tape is not procurable, cotton twine may be used, and same covered with paraffin by melting a candle held over the joint and rubbed with hot table knife.

The bells are now secured to the wall, bell end down, the covers being removed to do this. The wires are then connected to the terminals, and all is complete. If the battery has been set up long enough in advance, and the work properly done, a pressure on the push-button should ring the bell. If the bell does not ring, inspect the work to see if all connections are made, and if all the parts are in working order. Where two or more bells are used, different tones should be used to enable them to be distinguished. A wooden shell can be used to replace a bell where a loud sound is not necessary.

BORING HOLES IN METAL OR WOOD.

Should any of the readers of this Magazine have occasion to bore holes in metal and are not equipped with a powder-drill, they will find the drill illustrated by the figure, suitable for such work. It is used in an ordinary bitstock, and up to $\frac{1}{4}''$ or $\frac{3}{8}''$ will drill soft steel, iron, brass or other metals. It will not be injured, when boring through wood, by contact with nails, screws, etc., and will bore through any kind of wood without splitting it. For these reasons, it is a very handy tool for the amateur, and, being of low price, should be added to the tool equipment as occasion requires.

In Paris a new electric fire pump, which contains 100 gallons of water and is ready to start for a fire at any moment, is proving quite a success.

OLD DUTCH FURNITURE.

A Small Table.

The revival of the Old Dutch in household furniture affords the amateur many opportunities to display his skill, which needs not to be highly developed to produce many useful as well as ornamental furnishings for the home. Careful work and sharp tools are the main requisites, for upon the latter the former greatly depends. This is the first of a series of descriptive articles giving the necessary directions for making such articles as tables, desks, bookcases, china-cabinets, settles, beds, etc., all of which can be constructed by any one of ordinary skill and with a moderate equipment of tools. Much of the material may be obtained of the lumber dealer sawed to actual dimensions at but little extra expense, if pencil drawings of shapes and sizes be furnished with

the order, greatly reducing the heavy work that otherwise would have to be done. Such parts of the work as may be advisable to have done at the lumber dealer's will be indicated. Before beginning the construction of any of these pieces the necessary tools should be put in first-class condition. The time spent in doing this will be fully regained in the work to follow.

The first subject for trial is an occasional table of solid oak, its completed form being shown in the accompanying sketch. The top is $40''$ long, $28''$ wide and $1\frac{3}{8}''$ thick. As the work of gluing up the top requires clamps to hold the boards firmly together while the glue is drying, as well as accurately planed edges to avoid cracks, this work had best be done at the lumber-mill if it is possible to have it. The glue should be allowed to

become thoroughly dry before the top is fastened to the frame.

The parts for the frame include four pieces for the legs 2⅝″ square and 28½″ long; two pieces 43½″ long and 2½″ wide and 1″ thick for the top of the frame to which the table top is attached; two pieces 21″ long, 5″ wide and 1″ thick, and one piece 32⅝″ long, 4″ wide and 1″ thick for the bottom of the frame. Also two small pieces for keys 3″ long, 1″ wide and ¾″ thick, and several pieces of ¼″ oak dowel.

Beginning with the legs, make the mortises for the cross-pieces. It is well to mark out with a pencil where the mortises are to come, the better to secure a good fit, and avoid the error of getting the mortises in the wrong sides. The mortises in the top end are 1″ wide, 1¼″ deep and ½″ from outside edge of leg, and extend 2″ from the end, the cross-pieces being cut down to fit, forming a shoulder which serves to make the frame rigid. With a bit bore holes to remove the wood, finishing with a sharp chisel, care being taken not to cut away too much wood and so cause a loose-fitting joint.

The mortises for the cross-pieces at the bottom of legs are 4″ long and 1″ wide, and are cut clear through the leg. The bottom of mortise is 4½″ from the bottom end of the leg.

The cross-pieces for the top of the frame are then prepared. The two side pieces are 27¾″ long and 2½″ wide. For the tenons on each end to fit the mortises in the top of the legs, cut a piece ½″ wide and 1¼″ long from the lower side of each end. The two end pieces are 17¾″ long, and pieces are cut from the lower side of each end, the same size as from the side pieces. Three holes in the side pieces and two holes in the end pieces are bored into the under sides to receive the screws that fasten the top in place. They should be ½″ in diameter to the depth of 1½″, and a trifle less than the diameter of the screw for the balance. The screws should be 1¾″ long and about ¼″ diameter.

The end pieces at the bottom are 21″ long, tenons being cut at both top and bottom of each end, 2⅞″ long and ½″ deep. The edge of the ends are beveled slightly with a plane to make a neat finish. In the center of each piece is cut the mortise to receive the bottom cross-piece, which should be 3″ high and 1″ wide. When these end pieces are complete, they are, together with the top end pieces, set tightly into the mortises in the legs, care being taken to see that the pieces are squared with each other. Then ¼″ holes are bored clear through the legs for dowel-pins to fasten the frame together. The dowel-pins are driven in, each end being sawed off flush with the leg and carefully smoothed over.

The bottom cross-piece is 32⅝″ long, tenons being cut, at top and bottom of each end, 2½″ long and ½″ deep. In the center of each end cut holes for the keys 1″ high and ¾″ wide, the outer edges being ¾″ from each end. The ends of the piece are also beveled, about a ¼″ bevel being made. The keys are straight pieces, 3″ long, 1″ wide and ¾″ thick in the center, each end being beveled off to ⅜″ thick. The cross-piece can now be placed in the mortises, the keys driven in place and secured by glue, when everything is found correctly fitted. The top side pieces are also secured by dowel-pins, and the frame is complete. See that all joints are correct before the final fastening.

To attach the top of the table to the frame, place it top down, on suitable supports, preferably two low carpenter's horses. Place the frame in position. At the ends the legs will be 5″ from the end of top, and at all sides 4″ from the edge. Bore holes in the top ¾″ deep, to match those made in the frame, setting screws in one or two holes, before making the balance, to ensure correct work. The table should now be carefully smoothed over with fine sandpaper, any holes being filled with putty. A convenient way of using the sandpaper is to wrap a strip around a small flat block of wood, changing the paper as soon as it becomes smooth.

A dark green or brown stain is the most desirable finish for the table, but before this is applied it is given a coating of filler. This prevents the grain from raising, and keeps the surface smooth. The filler, and a suitable stain and polish, can be procured of any paint dealer. The many excellent prepared stains and polishes now to be obtained at low cost, obviate the necessity of making them. At best the processes are complicated, and the materials not easily found, even in the large cities. The polish should have but little glaze, the graining of the stained oak giving the necessary character and tone to the work. A table, constructed as here described, will be found both useful and ornamental.

AMATEUR WORK.

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INTRODUCTORY.

In these days of many excellent magazines, the advent of another seeker for public favor may seem to require explanation for its existence and the field it proposes to occupy. The name, Amateur Work, supplies this information in part; the subjects included in this issue being typical of those to follow. Its aim will be to assist the amateur worker to obtain knowledge and skill in the many avenues that lie open to those who desire to learn, but who may have had difficulty in obtaining the elemental knowledge that must be acquired before advanced work is attempted. Most of the textbooks and trade papers presuppose a practical knowledge of the subject, and the elemental portion is omitted. This lack of practical instruction is a serious one, which this magazine will endeavor to overcome. A prominent feature will be constructive work for those who already possess a fair degree of handicraft, and who desire to improve leisure moments in a useful manner. Electricity, in its manifold development, will be given comprehensive, theoretical and constructive treatment. Household furnishings will receive adequate attention, as will also wood-carving, wood-turning, modeling, drawing, photography, astronomy; in short, everything that the amateur worker can accomplish within the home or workroom will find its place in these pages.

The special wants of readers will be met in the correspondence columns; answers to all proper inquiries being given by letter, in addition to publication.

The editors of the several departments are practical workers, and their presentation of the various topics will be in accord with the present-day practice. The instruction, whether practical or technical, will be accurate, and can be accepted by the novice with the knowledge that the methods he is following would receive the approval of the professional worker.

The thrifty mechanic, the young apprentice in the shop, the student in the technical trade or manual-training school, will all find Amateur Work a source of inspiration and self-help that cannot fail to be productive of advancement and profit. In time, the volumes will provide a store of industrial information, which will be invaluable to their possessor, approximating, as they will, the scope of a mechanical and scientific encyclopedia.

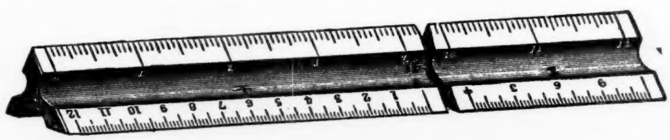
Dr. Armitage, an English physician, has used electric baths in the treatment of chronic lead poisoning, and in 40 severe cases 37 were benefited, some being completely cured. The rapid improvement is attributed to the change of the lead salts in the body into new and insoluble compounds. The apparatus used consisted of a large porcelain bath-tub, carefully insulated and provided with a large carbon negative electrode at the foot and a small movable carbon positive electrode, and a battery of 120 large Leclanché cells, connected in threes.

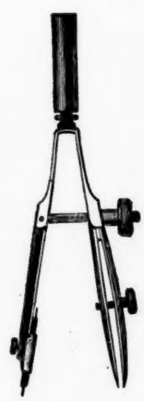
MECHANICAL DRAWING.

Earnest T. Child.

I.

INSTRUMENTS.—THEIR USE AND CARE.





The student who is ambitious to become a draftsman must, like any other artisan, become perfectly familiar with his tools before he may attempt to perform his work. Of course, experience will in time teach one the proper use and care of his instruments, but the man who is forewarned is forearmed, and "a stitch in time may save nine," as the old proverb goes. It has been thought wise, therefore, to preface our talks on mechanical drawing by a few words on the use and care of drafting instruments, together with a brief description of those necessary and others which, while not absolutely indispensable, may aid in the production of more uniform and perfect work.

Set of Instruments.

The first requisite of any draftsman is a set of drawing instruments. This may be secured at a price varying from four or five up to twenty-five dollars for a set. One which will fill every requirement, and will last a long while with proper care, may be obtained for about ten dollars. It is foolish for a beginner to pay more, and on the other hand a cheaper set will not be apt to retain its accuracy, so this may be set down as a fair average figure. The instruments which should be found in such a set comprise the following:

One pair 6″ dividers with fixed needle-point, pen, pencil, and lengthening bar; one pair 5″ plain dividers with hairspring adjustment; one pair spring-bow spacers, one spring-bow pencil, one spring-bow pen, one 5″ pen and one $4\frac{1}{2}$″ pen.

To work readily, none of the above instruments may be dispensed with, though it would be possible to get along with a single pair of dividers with pen and pencil point. The advantage of the spring-bow instruments lies in their small size, and the fact that they will stay where adjusted and enable one to duplicate circles in any part of a drawing.

The hairspring adjustment on the plain dividers

is very handy and saves much time and patience. This attachment is also applied to the larger divider, but it is not popular among professional draftsmen, although it has been found very useful by the writer. In selecting a set of instruments, the most important point is that the pens are of the best quality. The other instruments may be of a second grade, but the pens must be strictly first class. Those manufactured by Theo. Alteneder are considered the best, and they are certainly worth the difference in cost. The necessity of having first-class pens must appeal to all, as a large part of the finishing work has to be done with them.

Great care must be taken when using instruments to keep them in good condition. The box should be closed at night after work is over, the instruments having been previously wiped with a small piece of chamois skin kept for the purpose, and no dampness should be allowed near them. Pay particular attention to the care of the pens. Almost all drawing inks will corrode them more or less, and they should be carefully wiped, not only at the end of the day's work, but also at intervals during the work. The best penwiper is made of an old piece of sheet or shirt that is past other usefulness.

Drawing Board.

Drawing boards are of many kinds and sorts, varying in size from one large enough for a sheet of letter-paper to the long table used in railroad offices for profiles and other very long or large plans. The most convenient size is 23″ x 31″, built of 1″ pine, with cleats at the ends to prevent warping, and may be made at home, or may be purchased for about one dollar. The edges of the board should be straight, and it must be square, so that any side may be worked from. The best boards are made by gluing together narrow strips of pine and then planing the whole smooth. Pine is the most satisfactory wood, as it takes the thumb-tacks most readily.

The Square and Triangles.

The tee square consists of a long, thin strip of wood with its edges straight and with a cross-piece attached to one end at right angles. This cross-piece slides along the edge of the drawing board, and permits of drawing parallel lines. Triangles are used for drawing vertical lines from those drawn to the edge of the tee square. These are made in two forms; first 45 degrees having one right angle and two angles of 45 deg.; second, 30 x 60 deg. having one right angle, one 30 deg. angle and one 60 deg. angle. The 45 deg. triangle is used for cross hatching, and the 8″ size is the most convenient. It is necessary to have but one 30 x 60 triangle of about 6″ size, but it is very convenient to have another about 10″, making three triangles in all. The cost of a plain pearwood tee

square and three rubber triangles will be about two dollars. The rubber triangles however have been almost entirely superseded by transparent "amber" triangles, and the plan tee squares have been given place to others fitted with air edge of transparent substance; and while the expense is slightly greater, they are worth the larger outlay. One irregular curve will be found very useful on special work, especially in connection with machine drawing. Thumb-tacks are used for securing the paper to the drawing board. These are short tacks with

a large metal head, which makes them readily removed from the board. The most convenient size is about $\frac{3}{8}''$ diameter, with short points. First-class pencils must be used. There are several makes; but those manufactured by A. W. Faber are very reliable for grade and quality. For paper drawing H H is the proper grade, though some prefer harder; while for marking on tracing cloth a softer pencil, H grade, must be used. Nearly all pencil drawing is done on paper, and then traced in ink on the tracing cloth. Almost any rubber

may be used, but for general work Tower's Multiplex is best, and Faber's circular is most convenient for fine work when there are many lines, only one of which is to be erased. Sand rubbers are made for erasing ink, and these should be always used in place of a knife, as the latter spoils the surface of the paper or tracing cloth, and makes it difficult to make a clear ink line after erasing. India ink in stick form was for a long time considered superior to all other inks. It had to be ground in a saucer, and it was necessary to grind it fresh nearly every day. While this is still used in some drawing-rooms, in a majority of instances it has been superseded by liquid ink of some make or other. The best liquid ink is manufactured by Higgins, and is almost universally used. In school work it is customary to have the pupil work on Whatman's drawing paper. This is the best paper made, and is comparatively expensive, listing 90 cents per quire for 15″ x 20″ size. A manilla detail paper may be obtained, which will answer every purpose, and not cost nearly so much. This is the paper most commonly used in drawing-rooms for laying out details of machines, etc. No draftsman's outfit is complete without a scale. The most convenient style of scale consists of a triangular piece of boxwood about 12½″ long. Being triangular it presents six straight edges, which are subdivided for scale drawing so that one inch may equal four, eight, or any number of feet. The common scales are ⅛″ to 1′, ¼″ to 1′, ⅜″ to 1′, ½″ to 1′, ¾″ to 1′, 1″ to 1′, 1½″ to 1′, 3″ to 1′ and one side is divided into inches and sixteenths of an inch.

The above-described outfit will be quite sufficient for any draftsman's needs, but there are other instruments which will often be found helpful. The first of these is the beam compass, which must be used where large radius circles are to be drawn. Proportional dividers are very useful in transferring a drawing from one scale to another, and a pentagraph may be used for the same purpose.

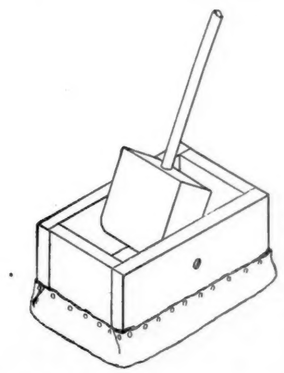
In laying off angles other than a right angle, a protractor must be used. This is a semicircle, subdivided into degrees. There are several devices in use for drawing section lines, but space does not permit of a full description of them.

(To be continued.)

The premiums offered are not cheap toys, but well-made and usable articles.

WAXED-FLOOR POLISHER.

Waxed floors require regular and thorough attention, if the surface is to retain the appearance so much desired by all good housekeepers. This involves much laborious work, which may be avoided by using the polisher here described. The base is a strong wooden box 10″ long, 6″ wide and 5″ deep. Several layers of old cloth, cut from a discarded garment, are tacked to the bottom for padding. A strip of heavy Wilton or other pile carpeting, 14″ long and 10″ wide, is then tacked over the padding. The carpeting around the sides prevents the polisher from scratching the baseboards or other furniture of the room. A suitable piece of carpeting can generally be found in the waste-box of any carpet-store.



The handle is made from an old broom or mop handle and a block of wood, the width of the latter being a trifle less than the inside width of the box, and 5″ long and 3″ thick. A hole 2″ deep is bored in one end large enough to hold tightly the handle, which should be glued or nailed, to hold it firmly in place. In the center of the sides of the box, 2″ from the top edge, bore two holes for two ½″ lag-screws that should fit these holes loosely, and be screwed into the block 2″ from the lower end. This allows the handle to be adjusted to push either way. The empty space in each end of the box is used for the weights. Flatirons or bricks are suitable. The polisher is pushed along the floor, and requires but little labor to give the floor a nice polish. Powdered wax is the most suitable to use with this polisher, and a little should be sprinkled on the floor before using the polisher.

TELEGRAPH INSTRUMENTS.

Frederick A. Draper.

A set of telegraph instruments adequate for good work on a short line may be easily and cheaply made, and much interesting and profitable information obtained therefrom.

As a preliminary to experiments in wireless telegraphy, the work here required would be most valuable, a thorough understanding of all the different parts of ordinary instruments being absolutely necessary to satisfactory results with the wireless. The parts here described, consisting of key, sounder and battery, are patterned closely after the instruments in regular use, having the different adjustments, from the use of which may be learned all that an expensive outfit would supply. A fret-saw would be very useful in the work, but may be dispensed with.

The Key.

The key and sounder are made upon a base, A, of any suitable wood, 8″ long, 5″ wide and ½″ thick. The key will be first described. The two supports, B, are ⅜″ thick, 1¾″ long, ⅝″ wide, cut in to form shoulders at the lower end. These are fitted to holes cut in the base A, 1⅛″ apart, the outer one being 1½″ from the right end. The lever C, at the part between the supports, is 1¼″ wide and 5″ long; preferably of the shape shown in Fig. 1, but may be a straight piece. A round-headed brass screw, F, is put through, 2⅜″ from the front end, the wire M being carried around the screw under the head. The brass screw-eye G is

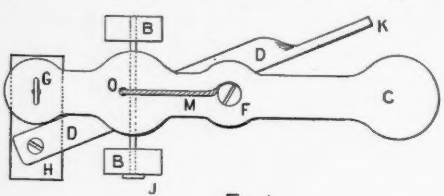


Fig. 1

⅜″ from the other end of the lever, and serves to adjust the degree of movement desired for the lever. A wire nail, J, holds the lever in place. It should fit tightly into the lever, but have play enough in the holes in the supports to move without friction. A small hole, O, is bored through the lever, for the wire M to be run through loosely to the under side of the lever to the terminal screw H. The terminal screw E is put through a section of a common thread-spool or other round

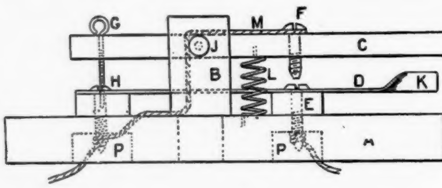


Fig. 2

section of wood, which has been glued to the base. The space is left for the arm D to slip under the head of the screw and make a good contact. The top of the head is filed off a little, to make a flat contact with the point of the screw F, which has also been filed flat. A 1″ hole, P, is bored in the under side of the base, to allow the screw E to project far enough to attach the wire connection. Two or three turns of bare wire around the point of the screw will answer, but soldering would be better. The compression spring L keeps the lever up, except when pressure is applied in transmitting messages. A rubber band attached to the other end may be used, if this spring is not easily procured. The spring is kept in place by the ends, which are straightened out to fit into holes in the lever C and base A. These holes can be made with a small awl.

The circuit-closer D consists of a strip of brass, held in place by the brass screw H, which passes through one end of a piece of wood, 1⅜″ long, ⅝″ wide and ¼″ thick, into the base A and the hole P, allowing the end of the screw to be used to attach connecting wire. The other end of the wooden block serves as a rest for the point of the screw-eye G, a flat-headed brass screw being put through to hold the wood in place and prevent excessive wear from the screw-eye. The other end of D is bent a quarter turn, to form a resting-place for the finger when opening or closing the circuit. The wire M is 16 or 18 double-covered copper wire. The ends being stripped of the covering, one end is

carried around the contact screw F, and the other end through a small hole in the base, to the point of the terminal screw H, the screw F being turned tight to hold the wire in place. The connections of the screw H and wire should be soldered, if possible. Four brass-head upholstering nails, one under each corner of the base, make good legs, and prevent the connecting wires from being injured. Regulate the screw-eye G, so that the lever C has sufficient play to separate the point of screw F, about $\frac{1}{16}''$ from screw E.

The Sounder.

The only part of the sounder requiring special care in construction is the electro-magnet D. This should be made very carefully, as upon its proper working depends the success of the whole apparatus. The function of the electro-magnet, when excited by an electric current, is to attract the armature F, this movement of the armature making the "click," which the experienced operator recognizes, and so reads the message that is being transmitted. The well-known "horseshoe," or permanent magnet, attracts pieces of iron, and holds them in close contact until removed. An electro-magnet differs, inasmuch as it only has

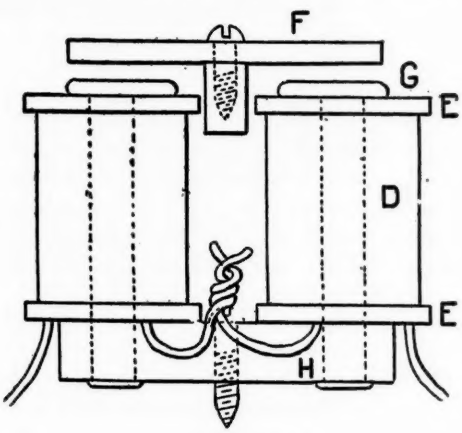


Fig. 3

attractive power while excited by the electric current. If an electro-magnet does not at once lose power when the current ceases, it is evident that the iron core is not of soft enough iron.

An electro-magnet, as here described, consists of the iron cores, G, the connecting iron base, H, the wiring, D, and nonconducting face-plates, E. The cores must be of very soft iron, $1\frac{3}{4}''$ long and $\frac{1}{4}''$ diameter. Iron rivets will answer, though Norway bar iron would be better. If any doubt exists as to the iron being soft enough for the purpose, by placing it in a coal fire in the stove

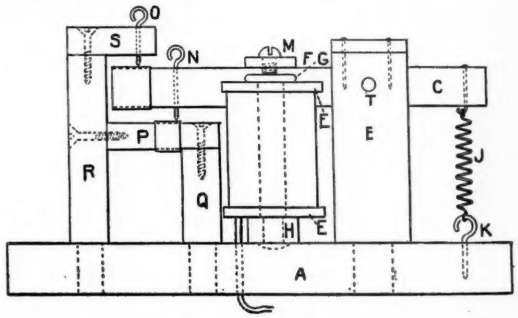


Fig 4

and heating it to a red heat, and then letting it get cold as the fire dies out, the required softness will be obtained. Hard iron will not be suitable, as it retains magnetism imparted to it by the electric current, while soft iron does not. The core must quickly demagnetize, otherwise the armature would not immediately separate from the core after being attracted to it, making it impossible to correctly transmit the signals. Having obtained suitable cores, they should have the lower ends filed down to fit holes drilled in the base H, which consists of a flat piece of soft iron, $2''$ long, $\frac{1}{2}''$ wide and $\frac{1}{4}''$ thick. The holes should be $1\frac{3}{8}''$ between centers, and $\frac{3}{16}''$ in diameter. An additional hole is bored in the center of H to receive the screw S. The cores can be filed down to fit, with the ends projecting slightly through the holes, and after being wound with wire, permanently held in place by carefully hammering a flange or head. After fitting the cores, they are removed and fitted with the insulating material. This consists of a round ebonite washer at each end, $1''$ in diameter, with the center hole, through which the core passes, made a snug fit. Two small holes are drilled in the washer at the lower end of the core, one hole close to the core hole, and the other $\frac{1}{8}''$ from the outside edge. These holes are for the ends of the coil wire to pass through. These washers are $1\frac{1}{8}''$ apart. Between them, and around the core, are wrapped three or

four layers of waxed paper, care being taken to have the edges of the paper meet the washers, or, if available, a piece of ebonite tubing may be used. They should then be wound, beginning at the lower end, with No. 22 or 24 double silk-covered wire, laid on in even layers until the diameter of the coil reaches $\frac{3}{4}''$, the end of the last layer being at the same end of the core as the first end. Wind regularly and evenly. Any slight ridges may be corrected in the last layer by winding a strip of note paper once around the next-to-the-last layer, and winding the last layer over the paper. Three inches of wire should be left at each end for connections, as hereafter described. One coil is wound in the opposite direction from the other, the wiring of the two coils when upright taking the direction of the letter ∽. Another way of determining the direction of the wiring is by putting the two lower ends of the core together, to form a straight line. The wiring on both cores should be in the same direction as though they were a single piece. The winding completed, give the outside layer a coating of shellac, which will prevent moisture from interfering with the working. The appearance can be improved by covering with a strip of leatheret, the kind used by bookbinders for book covers. The coils are then fastened to the base H, the two outside ends of the wires being cut a suitable length, stripped of the covering, twisted together and soldered. (See Fig. 3.) To prevent any possibility of leakage of the current from the wire to the iron base, wrap the joint with twine, and cover with wax, or with bell-hanger's insulating tape. The electro-magnet is now complete, and may be put aside until the rest of the sounder is ready.

Two uprights B are now made, $2\frac{3}{8}''$ long, $\frac{5}{8}''$ wide and $\frac{1}{4}''$ thick, with the lower ends cut to form shoulders, as shown in Fig. 4. A cross-piece R, $\frac{1}{4}''$ thick and $\frac{5}{8}''$ wide, is nailed to the tops of supports. The lever C is $3\frac{5}{8}''$ long, $\frac{3}{8}''$ wide, and $\frac{3}{8}''$ thick.

The armature F consists of a flat piece of soft iron $2''$ long, $\frac{1}{2}''$ wide and $\frac{1}{8}''$ thick, with a hole drilled through the center for the screw M, which fastens to the lever C. The screw-eye N is $\frac{5}{8}''$ from the end of C, a hole first being made with an awl, to prevent the splitting of C. Another hole is also made with an awl $1''$ from the other end of C to receive the wire nail or piece of steel wire which serves as a bearing. The holes in C should be tight; the corresponding holes in the supports B should be large enough to allow free play of the lever C and prevent binding, and yet be without side motion.

At the front end of the lever C make a hole to receive the small wire nail or large pin L, which should move freely, so as to turn with the spring T when adjusting the tension. The end of L is turned into a hook to hold the loop of the spring. The screw-eye K holds the outer loop of the spring, which should be without tension when K is almost unscrewed. The spring should be quite sensitive, as the lever C requires to be kept nicely balanced, and respond easily to the "pull" of the electro-magnet on the armature. A rubber band may be used in place of the spring, but is not so good for the purpose. On the other end of the lever C tack a strip $\frac{3}{8}''$ wide of thin tin: a piece of an old tintype will do nicely. This is to increase the sound of the "click." A similar strip is tacked around P for the same purpose.

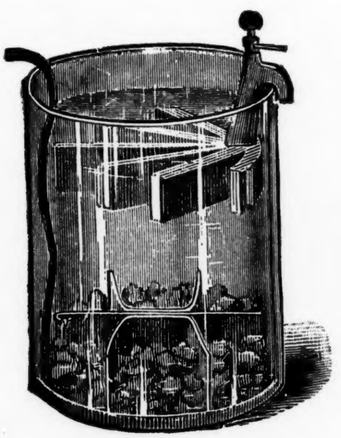
The frame for regulating the movement of the lever C consists of the upright posts Q and R and the cross-pieces P and S, made from $\frac{3}{8}''$ square strips screwed, together, as shown in Fig. 4. The lower end of the uprights Q and R have shoulders, and are glued to prevent loosening. Care should be taken to make the holes for the screws with a sharp awl, so as not to split the wood. The wooden parts being all in position, excepting the lever C, the electro-magnet is attached to the base by a screw, the inside ends of the coil wire being left free to attach, one to the line wire and one to the wire from key. In the regular telegraph instrument these wires are carried through holes in the base to terminal posts and key; but these are omitted in this description, but may be added if desired.

The lever C is now fastened in place by the wire nail T and the spring J attached. When the lever is in correct position the armature should, by pressing it lightly with the finger, not quite touch the ends of the cores, which are known as the poles of the magnet. The movement of the armature should be less than $\frac{1}{8}''$, and is adjusted by the screw-eyes N and O.

The Battery.

The battery is of the form known as the "Gravity" type, and consists of a jar of glass or stone-

ware; the positive element, zinc; the negative element, copper, and an exciting solution of sulphate of copper commonly called "blue vitriol." A battery can be purchased at low cost, and but little instruction is to be gained by making one; but the method is given for those who desire to try it. From sheet zinc cut three strips 2″ wide and 6″ long. Bind them together in the center with two complete turns of another strip ½″ wide and long enough to leave a free end 3″ long. Separate the ends so they will form a six-pointed star. From some sheet copper cut three strips 2″ wide and 6″ long. Rivet together in the center with copper rivet. Punch another hole through the strips just above the rivet and fasten a piece of copper wire, which, except where it is fastened to the strips, is covered with rubber insulating material. The ends



of the strips are then bent apart to form a star similar to the zinc. The copper is then placed in the bottom of the jar, which should be of about 8 quarts capacity. A pound of sulphate of copper in crystals is then placed around the copper strips, and water added to fill the jar to within about an inch of the top. A strip of wood is then placed across the top of the jar, the zinc lowered into the water till the top of the strips are covered about a half inch; the binding strip is then carried around the piece of wood, to hold it in position. Several hours are required for the battery to generate its full current of electricity. The line wires are attached, one to the zinc strip and the other to the copper wire, the insulation on the latter being removed and the line wire twisted enough to give plenty of contact. A battery of one cell makes only a weak current; so all connections must have plenty of surface to enable as much of the current to flow as possible. As brass corrodes, all connections should be brightened with a file or emery-cloth; and soldered if permanent. The brass terminal screws will need polishing at times, to enable the current to flow easily. It is to obviate this difficulty that platinum points are used on regular instruments.

Very few people have heard of automobile banks. Such, however, is the case, and the new institution is the property of the town of Mézières, in the Ardennes, France. In order to reach a savings bank the peasantry there have been compelled to leave their work and come to town, which meant to many a journey of several miles. Now, instead of having to go to the bank to deposit their savings, the residents on the outskirts of Mézières will have the bank brought to them. The new vehicle is unique in construction. It is propelled by electricity, and has four seats, one in front for the driver and three in the rear for the staff of the institution. These three seats surround a revolving table, located in the center of the carriage, on which the business of the bank may be transacted. Writing-desks capable of being folded up when not in use are arranged over each of the seats in such a way that when open they extend out from the sides of the carriage in a manner suitable for the use of persons standing outside who desire to open an account with the bank. On the table are to be found shelves for books, adequate stationery for the use of the clerks, and a small metallic strong-box. On certain prearranged days the car makes a tour of the country districts, stopping here and there as long as it may be necessary to dispose of the business in hand.

It is stated that one marked effect of the machinists' strike was noticed in a factory at Bridgeport, Conn. As a result of the disaffection among the workmen this company found it necessary to close one of its most important departments for a fortnight. During that time special machinery, designed by ingenious men, was quickly supplied, through the use of which one man was enabled to do the work of three, then four, and finally nine machinists.

ASTRONOMY FOR NOVEMBER.

SALUTATORY.

Of late years the number of those who take a more or less active interest in the science of astronomy seems to be rapidly increasing. The published descriptions of recently established observatories and the notices and reports of the results accomplished, with the increasing accessibility and reasonable prices of telescopes, have done much to foster this interest, and the increased facilities for scientific education, with the consequent increased frequency of the development of the scientific habit of mind, perhaps still more.

Many of those, however, who have procured telescopes after they have exhausted (save the mark!) the well-known objects, are at a loss to know how further to employ their instruments, and what to look for with them; many would like to engage in some course of observations which may have a real value, but do not know how to set about it, nor where to get the information necessary to enable them to do so.

Information and material exist in great abundance, but much of it is difficult of access; mostly scattered through the pages of various polyglot scientific periodicals, whose names the amateur may never even have heard, and couched in languages with which he may be unfamiliar. In many cases, also, he has not the time at his disposal to search for it.

To help such cases is one of the principal reasons for the existence of the astronomical department of this magazine.

For this purpose, as supplementary to the regular articles, it is our intention to open a regular column of answers to correspondents, in which we will endeavor to give replies to any questions which lie outside the scope of the textbooks and encyclopedias, or, where it can be done, give directions where and how to find the desired information or material, and thus encourage the habit of independent research, on which depends all real scientific growth.

We cannot undertake to answer all queries individually and personally, but will give them a place, when not outside the limit set above, in the column of Answers to Correspondents.

We shall be glad to welcome to our columns any original papers that may be offered, reserving, however, the right of rejecting any that from whatever reason we may consider to be unsuitable.

It is our purpose to open these columns to discussions on astronomical questions, so long as such discussions are carried on in a scientific spirit, and with due regard to courtesy; and we shall ourselves assume the sole right of judgment in this connection also as to where the line lies, and of excluding any communication in which we find it to be overstepped.

In some departments of astronomy much of the world's stock of information has been furnished, and many discoveries made, by amateurs; Tycho, Herschel, Rosse, Smyth, Dawes, Burnham, Barnard,—to name but a few of the long list,—all made their reputations as amateurs, and many have remained so to the end. It does not happen to every one to do such things as these have done, but any one who does faithful and conscientious work in the true scientific spirit will find himself welcomed to the fellowship of such men, and sure of their sympathy, appreciation and encouragement in any good work he may undertake; and this sort of sympathetic freemasonry is one of the great compensations of the scientific life, which is in no sense a life of ease or luxury.

Of course not all amateurs have the intention or the opportunity to go so far as this, but many soon tire of a desultory course of "star-gazing" (an expression always used with a certain undertone of contempt among the real workers), and wish to engage in some line, however limited, of original work. The reader would be surprised to learn to how great an extent our observatory staffs have been recruited from this element; and this not from the men of national reputation, but from those only known among the workers themselves.

The true scientific spirit is well voiced by Kenyon Cox in some fine lines which, though written for the artist, find a response in the heart of every man possessed of the true purpose:

> "Who works for glory misses oft the goal;
> Who works for money coins his very soul.
>
> "Work for the work's sake, then, and it may be
> That these things shall be added unto thee."

Constellations for November.

On the first of the month, at eight o'clock in the evening, the zodiacal constellations above the horizon, in their order from east to southwest, will be as follows: Taurus, Aries, Pisces, Aquarius, Capricornus, and Sagittarius. As we face eastward, the brilliant and extensive group formed by the Pleiades, the Hyades and Aries at once attracts the eye; above Aries, and just east of the zenith, lies the great "square" of Pegasus.

The northeast is brightened by Cassiopea, Perseus and Auriga, the latter led by its *lucida*, Capella, second only of all the stars then above the horizon to Vega, which in turn yields the palm of brightness only to the great Sirius himself.

The Polestar holds the "empty places" of the north almost alone, accompanied only by the Guards, and watched from the northern horizon by the Greater Bear. From the zenith downward to the northwestern horizon stream in brilliant array the Swan, the Lyre, Hercules, the Crown, gemmed with the bright stars Deneb, Vega, Ras Algethi, and Gemma.

South of this brilliant line, and due west from the zenith, lies Aquila, with its bright leader, Altair, and the small but old and well-known asterisms, Delphinus and Sagitta.

Below the zodiac is a dim-appearing region of small stars, relieved only by the great group of Cetus in the east, the lonely bright star Fomalhaut in the south, and the Galaxy region of Scutum in the southwest.

Four hours later, at midnight, the scene has changed; Hercules, the Crown, Aquila, Scutum, Capricornus and Sagittarius have set; Vega and Fomalhaut are trembling on the horizon in the northwest and southwest; but from due east to southwest stretches the northern stream of the Galaxy, studded and flanked by its retinue of blazing constellations, all the great ones of the northern heavens, from the Greater Dog in the east to the Swan in the northwest.

Canis Major, Canis Minor, Orion, Gemini, Taurus, Auriga, Aries, Perseus, Cassiopea, Andromeda, Pegasus, Cygnus, Lyra, all the greatest constellations of the north, are all in evidence at once.

And what an array of first-magnitude stars! Sirius, Procyon, Rigel, Betelgeuse, Aldebaran, Capella, Alpherat, Deneb, Vega; at the eastern end of the sparkling line the brightest, and at the western the second in brightness in the whole heavens.

All these constellations are rich in objects for moderate telescopes: in Canis Major, Sirius, by far the brightest star in the whole heavens, is also a star with a history; its possible change from a red star, as described by the ancients, to its present intense whiteness, its observed irregularities of proper motion, from which Bessel inferred the presence of the satellite actually discovered in 1862 by Clark, in the very place called for by theory, the strong suspicion amounting almost to certainty, that this companion shines by reflected light,—all combine to make it a most interesting star. The companion, however, is beyond the reach of modest equipments.

Four degrees south from Sirius is the fine cluster 41 Messier, visible to the naked eye, and a fine object in the telescope.

Orion, "the finest constellation in the heavens," is full of brilliant fields and interesting objects, of which we will only specify the brilliant star Rigel, and the great Nebula, which is conspicuous to the eye south of the three stars of the belt, and a glorious show in the telescope.

Taurus has the magnificent cluster of the Pleiades, unsurpassed in the heavens, and, near the star Zeta, at the tip of the northern horn, the wonderful "Crab" nebula, an oval cloud like a small comet in ordinary glasses.

In Auriga the brilliant star Capella, the third brightest to be seen in these latitudes, and the fine clusters 37 and 38 Messier are worthy of attention.

In Perseus is the famous variable star Algol, probably the first star which was noticed to vary in brightness; the splendid "Sword-handle" cluster in this constellation is a naked-eye object, and is a most glorious sight in even a small telescope; the cluster 34 Messier is also a fine low-power object.

In Andromeda, the well-known great nebula, 31 Messier, is visible to the naked eye, and has more than once been mistaken for a comet; the double (really triple) star Gamma Andromedæ is a beautiful colored object. There are many fine clusters and brilliant low-power fields in Cassiopea.

In Cepheusis, Herschel's celebrated "Garnet star," so called by him on account of its deep red color; it is the only one of these strongly colored

stars visible to the naked eye. The remarkable variable star, U Cephei, is in this constellation.

Cygnus, the great Northern Cross, is full of beautiful views; in fact, all along its middle line of stars you can hardly point a telescope and not find a brilliant field; of its many double stars we will only refer to Beta and Omicron 2 Cygni, both fine in color; there are many telescopic red and variable stars in this constellation.

All the above objects are readily found with the help of a good star-atlas, and all are within the scope of a good 3″ glass.

Planets for November.

The November skies will be poor in planets. In the twilight during the early part of the month, Jupiter and Saturn being low in altitude, comparatively little detail will be visible on either, as their positions are not favorable for observation. Mars is far over in the west, and sets early. Venus, during the first part of the month, sets at about seven o'clock; she is not a satisfying object for small telescopes, as she shows little except glare, and insists on calling your attention to every weak point of your instrument. Faultless indeed is the glass that can stand her criticism.

Mercury may be visible in the morning, about the 21st. Uranus shows nothing to a small glass, and Neptune can only be found with the help of graduated circles, and, when found, only identified with the aid of a chart showing all the stars down to the ninth magnitude, as it appears in the small glass as a star of the eighth magnitude, and only the great telescopes of the world stand any chance of raising a disc on it, or of showing its satellite.

The Moon.

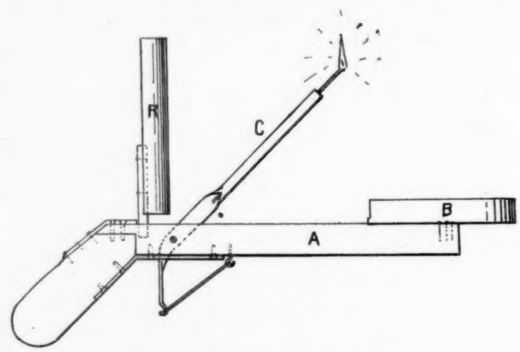
The November moon is new on the 11th, passes its first quarter on the 19th, and fulls on the 25th.

The moon is perhaps the most satisfactory of studies for a small telescope, as its nearness to the earth renders it the easiest of telescopic objects; the irregularities of its surface are visible with a very low magnifying power, even a field-glass showing the prominent features, while the continual change of aspect under the varying angles of illumination gives an endless variety, and all the objects of special interest at least can be seen with a 3″ glass. From the brilliancy of its illumination, the moon admits of the use of higher powers in its examination than does any of the other planets; in fact, the principal difficulty here is in the state of the air, the "seeing," as it is called. Even on the clearest appearing nights, this will often prove to be so bad as to render hopeless the use of any except the lowest powers. But during the temperate months of the spring and autumn there are often evenings when there seems to be scarcely any limit to the power that might be used.

Vega.

FLASH-LIGHT TORCH.

With the approach of winter, the amateur photographer begins to plan what he may do when inclement weather prevents work afield. Much pleasure can be derived from indoor work with a flash-light. The making of an excellent torch is a simple and inexpensive matter, as may be seen from the illustration. The materials required are: the cover of a tin spice-box, a small bean-blower, empty tin can, a piece of maple or birch 6″ long, ⅝″ wide and ½″ thick, and a few screws. The



spice-box cover serves as the flashing-pan B, and should be about 2½″ in diameter. A slot is filed or cut in one side, to allow the flasher to reach the powder. It is attached to the wooden rod by small wire nails. From the bean-blower, a small tin one, cut a piece 5½″ long. Then file a slot one-half way through 3″ from one end. The longer portion is left round, and to hold a wax taper or match. The shorter portion is hammered flat and a hole punched through it 3¾″ from the end, for a screw. This screw acts as the bearing, and is screwed up until the lever just works. Twist the flat end a quarter turn 1¼″ from the other end, and slightly curve it, like the trigger to a gun. The extreme end is curved to hold one end of a rubber band, the outer end of which is attached to a small hook on the rod.

The handle is a short piece of wood beveled to the rod, and fastened by screws and tin strips tacked over the joint. From the tin can is cut the reflector R, 8″ wide and 6″ high, to shield the eyes of the operator. One end of a wooden beef-skewer is split about three inches with a saw. The tin is placed in this slot, and two small wire nails driven through to fasten it. The sides are curved slightly towards the flash-pan. A hole is bored in the rod A to receive the bottom of the skewer, thus holding the reflector upright while in use, and allowing it to be packed flat for convenience in carrying.

To use, a charge of flash-light powder is placed flat in the pan and the wax taper lighted. When ready for the flash, press the trigger with the finger until the lighted taper reaches the powder. Hold the reflector between the flash-pan and the eyes.

ELECTRICAL ENGINEERING AND YOUNG MEN.

Professor F. B. Crocker is the author of an article in a recent issue of the *Saturday Evening Post*, entitled: "The Young Man and the New Force." He discusses in a most interesting and suggestive manner the opportunities and the requirements in the field of electrical engineering. He points out that the profession is one in which young men are peculiarly numerous and predominant, and says that having personally followed the careers of several hundred men, in electricity he is "convinced that they have gone ahead more rapidly than would have been possible in any other line of human effort. One of the reasons for this is that the industry is so new and has expanded enormously, forcing men ahead. The other reason is the fact that electricity is a peculiar subject. In its pursuit general intelligence or knowledge is not sufficient for pronounced success. A man possessing special taste for it soon differentiates himself from the others working alongside who may not be endowed with the same advantages. Such a man will forge ahead of his fellows at a rate that is absolutely impossible in any other calling in the world. The successful electrical engineer has more than mere ability. He is gifted with special talent, like the successful artist or the musician. Electricity is, to my mind, the only mechanical pursuit that has 'soul.' The successful electrician is born. Many of the qualities that are his are intangible, just as the fine musician's qualities are. But there must also be tangible qualities, certain fixed mental traits. He must have great mental alertness; the ability to think quickly, to grasp a given situation at once. He must be of an analytical turn of mind—that is, able to reason from cause to effect, or vice versa. In electricity one thing follows from another with absolute certainty."

While admitting the fact that electricity is more or less of a marvel in spite of its exactitude, Professor Crocker criticises the popular idea that electricity remains unknowable. He contends rather that the proper attitude of the electrical worker is that of willingness to accept innovation, and not of prejudice against it. "It is the first duty of an electrical worker to fall in with rapid advances and radical departures. Therefore, a necessary qualification for the successful electrician is an interest in things that are new *because they are new*. Any one with a strong conservative tendency would be at a disadvantage in the electrical field. This is probably the reason why Americans have got along faster than any other nation in the development and use of electricity. An American prefers a thing that is new, whereas a foreigner considers newness in itself an objection. The man who is interested in ancient literature, or in archæology, cares little for electricity. This is a fact I have observed among my own friends. Those who have gone into electricity with the idea of saving themselves labor have made a great mistake, because electricity requires fully as much application and intensity of purpose as any other line of work."

"But though these men and many others have done exceedingly creditable work and now fill responsible positions, it is a fact that the pay is not as large in the technical branches as it is in the administrative departments. This is true, however, in all other human pursuits. The technical men in a railway, for example, receive much smaller salaries than the executive officers. The same is true in chemical industries, and in many other lines. There is no more responsible position, or one requiring more knowledge or skill, than that of captain of a transatlantic liner, and yet his pay is comparatively small. The presidents of the steamship companies, with nothing like such direct responsibility, receive salaries ten

or twenty times greater than those of the captains of the vessels. By the technical man, $5,000 a year would be considered a very good and $10,000 an exceptionally large salary. There is one thing to be considered, however. In the logical development of the new business scheme that is controlling all our great corporations, technical knowledge is beginning to be more and more to the advantage of the men who seek the great positions in these corporations. As the years go by, the demand will certainly become steadily greater for a class of men who combine executive ability with a thorough technical understanding of the work they are called on to supervise. Already we have a number of striking examples of technical men who have won great business positions."

Professor Crocker sees few limitations to the growth of electrical industry, and believes that most lines of manufacture and transportation are becoming dependent upon it.—*Electrical World.*

THE METAL NIOBIUM.

This metal has lately been prepared in the pure state by M. Henri Moissan with the aid of the electric furnace. The properties of this metal have been practically unknown heretofore, the metal not having been prepared in the pure state except by Roscoe, who obtained it as a gray powder. M. Moissan now produces a considerable quantity of the metal in the electric furnace, starting from an American niobite which contains niobic and tantalic acids. An alloy of niobium and tantalum is first obtained by reducing the powdered mineral with carbon in the electric furnace. This alloy is crystalline, of a light gray color, and contains about two per cent of combined carbon. By a series of reactions the niobium is separated from the alloy in the form of niobic acid, which, after calcination, is a pure white powder. To prepare the niobium, the acid is mixed with powdered carbon and pressed into small cylinders; a number of these are placed in a carbon trough contained in a carbon tube, and the whole placed in the middle of the electric furnace. A few minutes' heating suffices, with a current of 600 amperes and 50 volts. The decomposition is violent, and as soon as the niobic acid becomes fused a lively effervescence takes place. After cooling, a well-formed ingot of metallic niobium is obtained, which contains from two to three per cent of combined carbon. The metal has been examined as to its physical and chemical properties. It is quite hard and scratches glass and quartz easily. It is not fused in the oxy-hydrogen flame, and therefore its fusing point is above 1,800 degrees centigrade, but in the electric furnace it liquefies easily. As to its chemical properties, it is found to vary considerably from most of the other metals. It does not decompose water vapor at a red heat, and is almost unattacked by acids. Hydrochloric and nitric acid and aqua regia have no action upon it; hydrofluoric and sulphuric acids attack it but slightly, but it dissolves rapidly in a mixture of hydrofluoric and nitric acids. The gases attack it more readily. Heated in fluorine, it becomes incandescent and gives abundant fumes of a volatile fluoride. Chlorine attacks it at 205 degrees centigrade, with disengagement of heat, producing a volatile chloride, $NbCl_5$ of a golden-yellow color. Bromine vapor forms a light yellow sublimate, but iodine seems to be without action. The niobium, reduced to powder, and heated in a current of oxygen, takes fire at 400 degrees with brilliant incandescence, forming niobic acid. When the powdered metal is heated in a current of nitrogen to 1,200 degrees, each particle becomes covered with a fine yellow coating of nitride of niobium. The action of carbon is somewhat curious. When the metal is maintained in fusion in the presence of graphite, it slowly absorbs carbon, which enters into combination. Niobium does not readily form alloys with the other metals. Sodium, potassium and magnesium may be distilled over it without combining, and it does not form an alloy with zinc. When heated with soft iron in fusion a small quantity enters into combination with the iron. The alloy shows an irregular structure containing fragments of niobium, a combination of the two metals, or, perhaps, a double carbide, and pure iron in excess. Oxide of chromium is reduced by the metal in the electric furnace, and gives a brittle alloy of chromium and niobium. Fused potash attacks the metal with the formation of an alkaline niobate. Chlorate of potash reacts upon it at a high temperature with brilliant incandescence, and nitrate of potash attacks it with violent disengagement of nitrous fumes. The reactions obtained with niobium seem to place it apart from the other metals and ally it to boron and silicon.—*Electrical Review.*